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Competition, Firm Turnover and Productivity Growth

by John R. Baldwin and Wulong Gu

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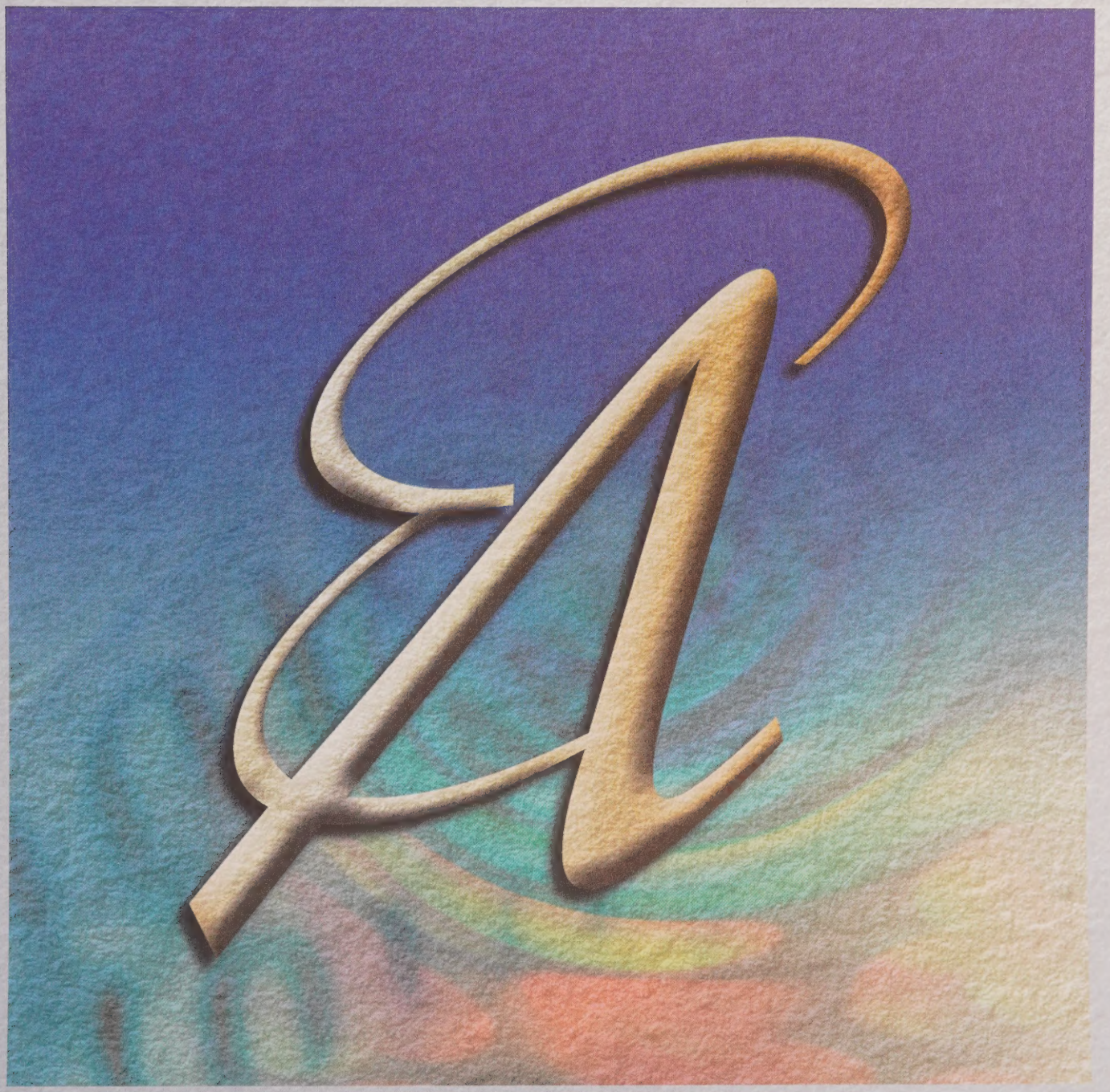

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Competition, Firm Turnover and Productivity Growth

by
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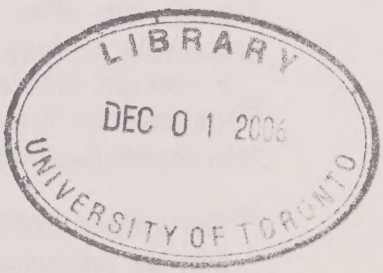

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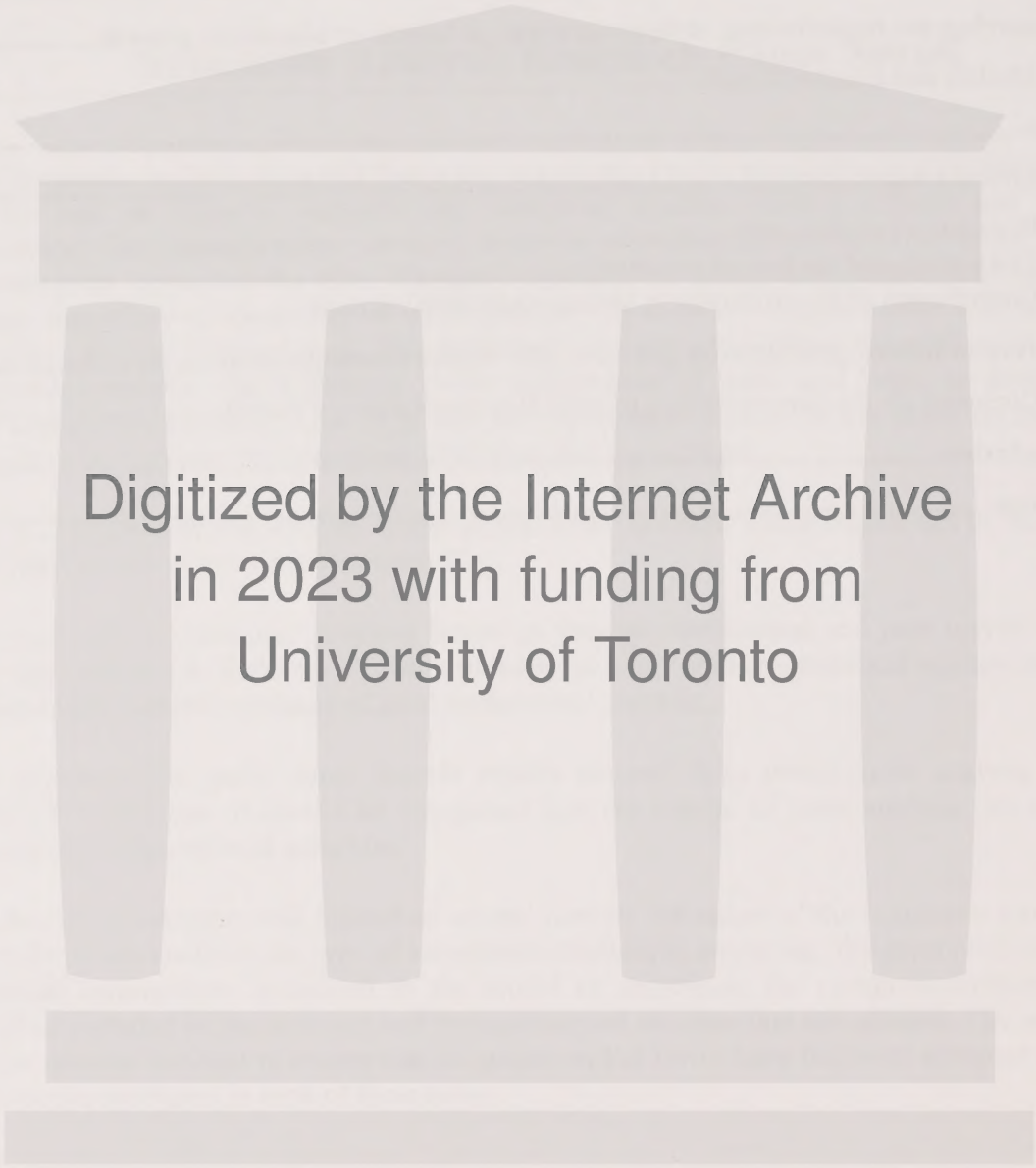

Abstract

This paper investigates the extent to which productivity growth is the result of firm turnover as output is shifted from one firm to another, driven by the competitive process. Turnover occurs as some firms gain market share and others lose it. Some of the resulting turnover is due to entry and exit. Another part arises from growth and decline in incumbent continuing firms. This paper proposes a method for measuring the impact of firm turnover on productivity growth and shows that this impact is far more important than many previous empirical studies have concluded. It argues that firm turnover associated with competition is the main source of aggregate labour productivity growth in Canadian manufacturing industries.

Keywords: competition, firm turnover, productivity growth.

Executive summary

This paper investigates the extent to which productivity growth is the result of firm turnover as output is shifted from one firm to another, driven by the competitive process. One part of turnover is due to entry and exit. The other part arises from growth and decline in incumbent continuing producers. Previously, we examined the impact of reallocation across establishments on aggregate productivity growth. In this paper, we measure the contribution of firm turnover and reallocation among firms to aggregate productivity growth. We ask how the shifts in market share from declining firms to growing firms enhances productivity growth.

Several studies have examined the contribution that this reallocation of outputs and inputs across individual producers makes to aggregate productivity growth. Many of these studies argue that reallocation often accounts for very little of aggregate labour productivity growth and that the main source of labour productivity growth comes from labour productivity growth within plants (see Organisation for Economic Co-operation and Development, 2001 and Scarpetta et al., 2002). The inference that is often drawn is that the competitive process is relatively unimportant when it comes to productivity growth. This paper argues that these other studies are misleading and based on imperfect analytical models.

In this paper, we argue that most previous studies underestimate the contribution of competition to labour productivity growth. To account for the contribution of output reallocation to labour productivity growth, we develop a decomposition method that measures the 'between-firm' component capturing output reallocation and the 'within-firm' component that consists of organic productivity growth that is unrelated to shifts in the relative importance of firms. We make use of a counterfactual calculation for this decomposition. In the counterfactual calculation, we ask what would have happened if we assume that there are no changes in the output shares of firms during the period. This produces an estimate of labour productivity change that would have occurred if there had been no change in market share—the within-firm component—and is different from the value of labour productivity change that was actually observed. The difference between what was actually observed and this counterfactual estimate is the between-firm component measuring the effect of output reallocation across firms that come from the competitive process of shifting output from one firm to another.

Most previous studies on firm turnover and labour productivity growth measure the contribution of the within-firm component to labour productivity growth, holding labour shares constant. This assumption is not neutral with respect to output shares. While there is no reallocation of employment across individual firms, there is an implicit reallocation of output taking place that is included in the within-firm component of this approach. It is just not recognized to be there. In particular, with constant labour shares and changing relative labour productivity, output and market share is shifted towards those firms with faster labour productivity growth. We show that this approach implicitly assigns most output share change to the within-firm component and therefore underestimates the between-firm component. In contrast, our decomposition focuses on output reallocation.

The results from using our decomposition method show that output reallocation and competition are an important source of labour productivity growth accounting for most of the overall labour

productivity growth in Canadian manufacturing over a 10-year period. For the Canadian manufacturing industries, about 70% of overall labour productivity growth is due to changes in market share across firms in the periods from 1979 to 1989, and from 1989 to 1999. In contrast, the alternative method produces results suggesting that competition made little contribution to productivity growth.

1. *Introduction*

This paper investigates the extent to which productivity growth is the result of firm turnover as output is shifted from one firm to another, driven by the competitive process. Firms constantly strive to outdo their competitors with regards to innovative products and innovative processes that reduce costs and allow lower prices. Innovation attracts new customers and allows some firms to move ahead of their competitors. This process transfers market share from laggards to winners, as some firms gain market share and others lose it. One part of turnover is due to entry and exit. The other part arises from growth and decline in incumbent continuing producers.

Empirical studies have shown that substantial resources are reallocated across producers as a result of the growth and decline process that is continuously transferring market share from some firms to others (Dunne, Roberts and Samuelson, 1988; Baldwin, 1995; Mata, Portugal and Guimaraes, 1995; Caves, 1998; and Davis, Haltiwanger and Schuh, 1998). Several studies have examined the contribution that this reallocation of outputs and inputs across individual producers makes to aggregate productivity growth (see Bartelsman and Doms, 2000; Caves, 1998; and Foster, Haltiwanger and Krizan, 2001 for reviews).[1] Many of these studies argue that reallocation often accounts for very little of aggregate labour productivity growth and that the main source of labour productivity growth comes from labour productivity growth within plants (see Organisation for Economic Co-operation and Development [OECD], 2001; and Scarpetta et al., 2002). The inference that is often drawn is that the competitive process is relatively unimportant when it comes to productivity growth. This paper argues that these findings are misleading and based on imperfect analytical models.

The previous empirical findings that reallocation is of little importance suggest that an extensive theoretical literature on industrial competition, ranging from that of Schumpeter (1942) to Aghion and Howitt (1992) is wrong. In these traditional models, reallocation is pictured as playing a critical role in aggregate productivity growth.

In this paper, we argue that most previous studies underestimate the contribution of competition to labour productivity growth. The literature on competitive advantage and corporate strategy views competition as a process whereby businesses gain markets from their competitors. It focuses on the various corporate strategies related to the development of marketing, advertising, and technology that contribute to the growth of successful corporations (Porter, 1985). These strategies are aimed at gains in market share. However, most of the existing studies on 'reallocation' focus not on product markets but on labour input markets. In this paper, we argue that this leads them to incorrect conclusions. Firms do not compete for their share of labour markets; they compete over their share of product markets. If we are to understand the impact of competition in product markets, we need to examine the effect of turnover directly in these markets.

1. See Hazledine (1985) for Canada; Griliches and Regev (1995) for Israel; Baily, Bartlesman and Haltiwanger (1996a, 1996b), and Foster, Haltiwanger and Krizan (2001) for the Unites States; and Disney, Haskel and Heden (2003) for the United Kingdom.

To account for the contribution of output reallocation to labour productivity growth, we develop a decomposition method that is a variant of that first proposed in Baldwin (1995) that measures the 'between-firm' component capturing output reallocation and the 'within-firm' component that consists of organic productivity growth that is unrelated to shifts in the relative importance of firms. In our decomposition, we make use of a counterfactual calculation. In the counterfactual calculation, we ask what would have happened if we assume that there are no changes in the output shares of firms during the period. This produces an estimate of labour productivity change that would have occurred if there had been no change in market share—the within-firm component—and is different from the value of labour productivity change that was actually observed. The difference between what was actually observed and this counterfactual estimate is the between-firm component measuring the effect of output reallocation across firms that come from the competitive process.

Most previous studies on firm turnover and labour productivity growth measure the contribution of the within-firm component to labour productivity growth, holding labour shares constant. This assumption is not neutral with respect to output shares. While there is no reallocation of employment across individual firms, there is an implicit reallocation of output taking place that is included in the within-firm component in this approach. It is just not recognized to be there. In particular, with constant labour shares and changing relative labour productivity, output and market share is shifted towards those firms with faster labour productivity growth. We show that this approach implicitly assigns most output share change to the within-firm component and therefore underestimates the between-firm component.

In contrast, our decomposition focuses on output reallocation. If we view competition and creative destruction as a process that leads to changes in market shares across firms rather than in changes in employment shares, our decomposition should provide a better measure of the contribution of competition to labour productivity growth.

The results from using our decomposition method show that output reallocation and competition are an important source of labour productivity growth, accounting for most of the overall labour productivity growth in Canadian manufacturing over a 10-year period. In contrast, the alternative method produces results suggesting that competition made little contribution to productivity growth.

To account for the contribution of competition and reallocation to productivity growth, this paper departs from most previous studies in another important aspect. Many previous studies examine the impact of reallocation across establishments on aggregate productivity growth. In this paper, we measure the contribution of firm turnover and reallocation among firms to aggregate productivity growth. We therefore ask how the shifts in market share from declining firms to growing firms enhances productivity growth since it is firms, not plants, that respond to competitive pressures arising in markets. It is at the firm level that the responsibility of overall performance of the underlying entities lies and where the decision-making authority ultimately rests. It is firms that make the decision to enter and exit a market, to reengineer particular plants and to close down others. While more intuitive, this firm-based focus is inherently more complex. A growing firm can encompass both growing and declining plants, new plants and

closed plants. Change measured at the firm level encapsulates the net effect of a myriad of actions at the plant level as we demonstrate.

The paper also differs from most others in that we distinguish between two types of firm entry and firm exit. Entry and exit of the first type take place as new firms build new plants and as departing firms do so by closing down plants (called greenfield entry and close-down exit, respectively). Firm entry and firm exit of the second type occur as firms acquire existing plants and divest existing plants (called acquisition entry and divestiture exit). We find that acquisition entry accounts for a larger portion of labour productivity growth than greenfield entry.

The rest of the paper is organized as follows. In the second section, we present our method for measuring the contribution of changes in market share to aggregate productivity growth. In Section 3, we discuss the data. In Section 4, we present empirical results from our decomposition method. In Section 5, we discuss alternate methods and reconcile the differences with our methodology. Section 6 concludes the paper.

2. *Measuring the contribution of firm turnover to labour productivity growth*

Previous empirical studies at the plant and firm levels have decomposed aggregate labour productivity growth into two main sources: the within-firm component—growth that occurs within producers—and the between-firm component—growth that occurs because of the reallocation across individual producers (e.g., Foster, Haltiwanger and Krizan, 2001, for the United States; Disney, Haskel and Heden, 2003, for the United Kingdom; Baldwin, 1995, and Baldwin and Gu, 2006, for Canada).

To examine the relative importance of these two sources of aggregate productivity growth, these studies all start by examining changes in productivity over time and decompose this growth into various components, along the way referring to the within-firm components as the 'pure' productivity effect and the between-firm components as the 'reallocation' effect.

A simple example that ignores entry and exit is warranted. In this paper, we will focus on labour productivity. When there is no entry and exit, the average labour productivity of an industry is equal to a weighted average of the productivity of individual firms,

$$(1) \qquad P_t = \sum s_{it} p_{it} ,$$

where P_t is the aggregate labour productivity in the industry in period t, s_{it} is the share of firm i in the industry employment, and p_{it} is the labour productivity of firm i in period t.

Differentiating Equation (1), we obtain

$$(2) \qquad dP_t = \sum s_{it} dp_{it} + \sum p_{it} ds_{it} + \sum ds_{it} dp_{it} ,$$

where d denotes the derivative with respect to time t.

Rewriting in discrete form, this becomes

$$(3) \qquad P_t - P_{t-1} = \sum s_{it-1}(p_{it} - p_{it-1}) + \sum p_{it-1}(s_{it} - s_{it-1}) + \sum (s_{it} - s_{it-1})(p_{it} - p_{it-1}).^{2}$$

Aggregate productivity will increase if, holding employment share constant, productivity increases within individual firms (the first term). It will increase if the employment share increases more in higher-productivity firms (the second term). It will also increase if productivity growth is higher in those firms where employment share is increasing (the third term).

The decomposition (3) and its variants that are used in recent studies are algebraic manipulations and as such are tautologies. It is interpretations that are sometimes applied to these terms with which we disagree. Most of the empirical studies label the first term on the right-hand side the pure productivity effect, the second term as the reallocation effect. The third term is sometimes allocated to the pure productivity effect, but more frequently as part of the reallocation effect. Then, many of these studies proceed to draw conclusions about the dynamics of the competitive process by providing empirical measures of each of these terms. For example, Hazledine (1985) and Griliches and Regev (1995) use this framework to argue that entry either contributes negatively to productivity growth or that it is unimportant.[3] Bailey et al. (1992) also use this framework. More recently, the Organisation for Economic Co-operation and Development (OECD, 2001) and Scarpetta et al. (2002) have used this framework to argue that most productivity growth comes from the pure productivity effect and that, implicitly, the competitive process is of little importance.

These empirical findings appear to challenge the conventional wisdom—that the process of creative destruction and the rapid pace of reallocation is essential for productivity growth. But the challenge is more apparent than real, since it is a result of taking an approach that is mechanical, that attempts to be model-neutral, but that makes implicitly questionable assumptions about the nature of the competitive process.

As we will discuss in Section 4, the main assumption, implicit in most previous decompositions, is that the effects of the competitive process should be measured by the effect of shifting employment across individual firms. Those decompositions measure the contribution of employment reallocation across firms to aggregate labour productivity growth. In the next section, we develop a decomposition method that measures the contribution of output reallocation across firms to aggregate labour productivity growth. The results from our decomposition show that firm turnover is an important source of labour productivity growth.

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2. There are several alternatives that can also be derived that differ from Equation (3) in terms of the time subscripts. For example, s_{it-1} can be replaced with s_{it} in the first term, which in turn requires changes in the second term. Other variants use averages of shares and productivity levels.
3. This is not the case for most of the Canadian studies for the reasons explained in this paper.

2.1 *Models and counterfactuals*

We argue that it is useful to let economics interpose on the mathematics of the decomposition exercise. In particular, we note that there are a large number of decompositions that can be used, each with a different empirical model or counterfactual underlying it, and for the purposes of transparency, it is best to be explicit about the underpinnings of the model. As economists, we do not have the luxury of arguing that our measures are model-neutral (Baldwin, 1995; Caves, 1998).

Counterfactual calculations in economic analysis are not new. Wood (1995) has used counterfactual calculations to measure the impact of non-competing imports from developing countries on labour markets in developed countries. Bertin, Bresnahan and Raff (1996) used counterfactuals to explore the effect on industrial productivity of reallocating output on a nation-wide basis to the most productive plants. Bernard and Jensen (1999) used a counterfactual that removes exports from total shipments of plants to examine the contribution of exporting to productivity growth.

In this section, we will present a decomposition method that measures the contribution that output reallocation across firms makes to labour productivity growth—but we will be explicit about the counterfactual that underlies it. We then present our empirical results using this model. In the next section, we explain how alternate decompositions implicitly rely on different models of how the world works, and/or what we want to actually investigate, and we assess their relevance to the issue at hand.

The observed change in labour productivity between two periods t and $t-\tau$ is the sum of changes among the continuing firms (C) and changes due to entering (E) and exiting (X) firms:

$$\begin{aligned}(4)\qquad \Delta P_{t,t-\tau} &= \sum_i s_{it} p_{it} - \sum_i s_{it-\tau} p_{it-\tau} \\ &= \sum_{i\in C} (s_{it} p_{it} - s_{it-\tau} p_{it-\tau}) + \sum_{i\in E} s_{it} p_{it} - \sum_{i\in X} s_{it-\tau} p_{it-\tau} \ ,\end{aligned}$$

where P_t is aggregate labour productivity in the industry in period t, s_{it} is the share of firm i in the industry employment, p_{it} is the labour productivity of firm i in period t, and Δ denotes changes over a period.

To measure the contribution from shifts in output across firms, we postulate a counterfactual as to what would have happened in the absence of the competition that accompanies market-share changes.

In the particular counterfactual chosen here, we assume that in the absence of the competition that leads to market-share change, both exiting firms and continuing firms would have remained in the market at the end of a period and that there would be no changes in their output shares during the period. That is, output growth would be the same across firms and would be independent of labour productivity growth at firms. We also assume that there would have been no entering firms.

Assumptions as to what would happen in the absence of an event are critical to the results and, therefore, those that are made here merit discussion. We assume that most competition occurs within separate sections of an industry—that growing continuing firms essentially replace continuing firms that are in decline, and that entrants replace those firms that exit. We do so because the Canadian empirical evidence suggests that this occurs. Entrants are small and are much less productive than continuing firms. It is not very sensible to argue, therefore, that they replace the continuing group. On the other hand, entrants are about the size of exits and have about the same productivity. It is, of course, likely that in some industries, entrants will take market share from existing firms, but the formula used here has been devised to measure average trends. A later section relaxes these assumptions and examines the sensitivity of our findings to a more complex replacement pattern.

We also assume that productivity growth in firms that continue over the period was the same as that actually observed. For the exiting firms, we presume that there would have been no productivity change if they had not been forced to exit the marketplace.[4] These assumptions explicitly require us to separate changes in productivity from changes in output shares. This is probably unrealistic, as we shall later argue, but is in the spirit of the decomposition literature that tries to separate productivity changes from market-share changes.

With these counterfactual assumptions about what would have occurred without competition and output reallocation, we can calculate counterfactual output, counterfactual employment and counterfactual labour productivity for each firm in period t. The difference between the actual aggregate labour productivity growth that was observed and the counterfactual aggregate labour productivity growth that would have been observed without the reallocation of market share will be defined here as the contribution from competition due to firm turnover.

The counterfactual output for the exiting and continuing firms in period t can be derived from reallocating the observed output at the end of a period across firms, using their output shares at the start of a period:

$$\hat{y}_{it} = s^{y}_{it-\tau} Y_t, \text{ for } i \in C \text{ and } i \in X, \tag{5}$$

where $s^{y}_{it-\tau}$ is the output share of firm i in period $t-\tau$. A circumflex over a variable (i.e., $\hat{y}$) is the counterfactual value of the variable. Y_t is the observed output in period t.

The counterfactual employment $\hat{l}_{it}$ for firm i in period t is calculated as the ratio of counterfactual output to labour productivity, where labour productivity is taken to be the actual observed labour productivity:

4. We could have assumed that the exits would have produced as much as the continuing plants that lost market share—but we take the more conservative position here that exits would have made no gains. We do so, because exiting firms are at the bottom of the ladder, below those plants that lose market share—and the latter make virtually no contribution to within-plant productivity growth over most decades (Baldwin and Gu, 2006).

(6) $$\hat{l}_{it} = \hat{y}_{it} / p_{it} = \left(\frac{s^{y}_{it-\tau}}{s^{y}_{it}} \right) l_{it}, \text{ for } i \in C, \text{ and}$$

$$\hat{l}_{it} = \hat{y}_{it} / p_{it-\tau} = \frac{Y_t}{Y_{t-\tau}} l_{it-\tau}, \text{ for } i \in X.$$

In Equation (6), we have made use of the assumption that the productivity of continuing firms in period t is the same as was observed and that the productivity of exiting firms was the same as observed in period $t-\tau$.

From the counterfactual output and employment for the continuing and exiting firms, the counterfactual aggregate labour productivity in period t can be calculated as:

(7) $$\hat{P}_t = \sum_{i \in C} \hat{s}_{it} p_{it} + \sum_{i \in X} \hat{s}_{it} p_{it-\tau},$$

where $\hat{s}_{it}$ is the counterfactual employment share of firm i in period t:

(8) $$\hat{s}_{it} = \frac{\left(s^{y}_{it-\tau} / s^{y}_{it} \right) l_{it}}{\sum_{i \in C} \left(s^{y}_{it-\tau} / s^{y}_{it} \right) l_{it} + \sum_{i \in X} \left(Y_t / Y_{t-\tau} \right) l_{it-\tau}}, \qquad \text{for } i \in C, \text{ and}$$

$$\hat{s}_{it} = \frac{\left(Y_t / Y_{t-\tau} \right) l_{it-\tau}}{\sum_{i \in C} \left(s^{y}_{it-\tau} / s^{y}_{it} \right) l_{it} + \sum_{i \in X} \left(Y_t / Y_{t-\tau} \right) l_{it-\tau}}, \qquad \text{for } i \in X.$$

The difference between the aggregate labour productivity that is observed in period t is the counterfactual aggregate labour productivity and is the contribution of output reallocation to aggregate labour productivity growth. It can be written as:

(9) $$P_t - \hat{P}_t = \left(\sum_{i \in C} s_{it} p_{it} + \sum_{i \in E} s_{it} p_{it} \right) - \left(\sum_{i \in C} \hat{s}_{it} p_{it} + \sum_{i \in X} \hat{s}_{it} p_{it-\tau} \right).$$

Rearranging the terms in the equation, we express the contribution from shifts in market share as:

(10) $$P_t - \hat{P}_t = \sum_{i \in C} (s_{it} - \hat{s}_{it})(p_{it} - p_{xt-\tau}) + \sum_{i \in E} s_{it} (p_{it} - p_{xt-\tau}),$$

where $p_{xt-\tau}$ is the weighted average of labour productivity of all exiting firms, estimated using employment as weights.

The portion of aggregate labour productivity changes that is not accounted for by output reallocation reflects the contribution from productivity growth taking place within firms, holding output shares constant:

(11) $$(P_t - P_{t-\tau}) - (P_t - \hat{P}_t) = \hat{P}_t - P_{t-\tau}.$$

Combining Equations (10) and (11), we arrive at the following decomposition of aggregate labour productivity growth:

$$(12) \quad P_t - P_{t-\tau} = \sum_{i \in C} (s_{it} - \hat{s}_{it})(p_{it} - p_{xt-\tau}) + \sum_{i \in E} s_{it}(p_{it} - p_{xt-\tau}) + (\hat{P}_t - P_{t-\tau}).$$

The first term measures the contribution to productivity growth from the reallocation of output across continuing firms. It is positive if output shifts towards the incumbent firms that are more productive at the end of a period. The second term measures the contribution from entry and exit. Together, the two terms measure the effect of output reallocation across firms—the between-firm component. The third term measures the contribution of within-firm growth.

In decomposition (12), we assume that entrants displace exits. We thus compare the productivity of entrants with that of exits to measure their contribution to aggregate productivity growth. Entry and exit makes a positive contribution when entering firms are more productive than exiting firms (for more details, see Baldwin and Gu, 2002).

To better understand the contribution from within-firm growth, we substitute Equation (7) in Equation (11):

$$\begin{aligned} \hat{P}_t - P_{t-\tau} &= \left(\sum_{i \in C} \hat{s}_{it} p_{it} + \sum_{i \in X} \hat{s}_{it} p_{it-\tau}\right) - \left(\sum_{i \in C} s_{it-\tau} p_{it-\tau} + \sum_{i \in X} s_{it-\tau} p_{it-\tau}\right) \\ &= \sum_{i \in C} 0.5(\hat{s}_{it} + s_{it-\tau})(p_{it} - p_{it-\tau}) + \sum_{i \in C} 0.5(p_{it} + p_{it-\tau})(\hat{s}_{it} - s_{it-\tau}) \end{aligned}$$

(13)

$$+\left(\sum_{i \in X} \hat{s}_{it} p_{it-\tau} - \sum_{i \in X} s_{it-\tau} p_{it-\tau}\right).$$

Equation (13) can be simplified as:

$$(14) \quad \hat{P}_t - P_{t-\tau} = \sum_{i \in C} 0.5(\hat{s}_{it} + s_{it-\tau})(p_{it} - p_{it-\tau}) + \sum_{i \in C} \left(0.5(p_{it} + p_{it-\tau}) - p_{xt-\tau}\right)(\hat{s}_{it} - s_{it-\tau}).$$

The first term measures the contribution from productivity growth within firms holding their employment shares fixed. This within-firm effect will be called the pure productivity growth effect here. To interpret the second term, we substitute the counterfactual employment from Equation (8):

$$\sum_{i \in C} \left(0.5(p_{it} + p_{it-\tau}) - p_{xt-\tau}\right)(\hat{s}_{it} - s_{it-\tau})$$

(15)

$$= \sum_{i \in C} (0.5(p_{it} + p_{it-\tau}) - p_{xt-\tau}) \left(\frac{(p_{it-\tau}/p_{it}) l_{it-\tau}}{\sum_{i \in C} (p_{it-\tau}/p_{it}) l_{it-\tau} + \sum_{i \in X} l_{it-\tau}} - s_{it-\tau}\right).$$

Equation (15) shows that if all firms had the same productivity growth rates, the term would be equal to zero. Therefore, the second term in Equation (14) reflects the effect of differential rates of productivity growth across firms and will be called the covariance term. The term will be

negative when labour productivity growth is negatively associated with employment growth across firms, holding output shares constant.

Putting all this together produces the following decomposition of productivity growth:

$$(16)\quad \Delta P_{t,t-\tau} = \sum_{i\in C}(s_{it}-\hat{s}_{it})(p_{it}-p_{xt-\tau}) + \sum_{i\in E} s_{it}(p_{it}-p_{xt-\tau}) + \sum_{i\in C} 0.5(\hat{s}_{it}+s_{it-\tau})(p_{it}-p_{it-\tau}) + \sum_{i\in C}\left(0.5(p_{it}+p_{it-\tau})-p_{xt-\tau}\right)(\hat{s}_{it}-s_{it-\tau}).$$

In contrast to previous decompositions that focus on input reallocation, our decomposition measures the contribution of output reallocation to aggregate labour productivity growth. According to our decomposition, firm turnover makes a positive contribution to aggregate labour productivity when the more productive incumbents gain market shares from the less productive. It also makes a positive contribution when the entrants displace the exits that are less productive.

Our decomposition will attribute all aggregate productivity growth to the contribution of within-firm growth if there are no changes in market shares across firms. This will occur if output growth is the same among firms and the higher productivity growth of a firm relative to the industry average is achieved through employment reductions but no changes in its market shares.

On the other hand, our decomposition will attribute all aggregate labour productivity growth to the effect of output reallocation if labour productivity does not change at firms but output shifts toward more productive firms from the less productive ones.

The decompositions (12) and (16) can be modified to allow for more than one type of entrant. In our empirical analysis, we will distinguish between greenfield entrants and merger entrants and between close-down exits and divestiture exits. If we assume that greenfield entrants displace close-down exits and merger entrants displace divestiture exits,[5] the decomposition (12) can be rewritten as:

$$(17)\quad P_t - P_{t-\tau} = \sum_{i\in C}(s_{it}-\hat{s}_{it})(p_{it}-p_{xt-\tau}) + \sum_{i\in E1} s_{it}(p_{it}-p_{x1t-\tau}) + \sum_{i\in E2} s_{it}(p_{it}-p_{x2t-\tau}) + (\hat{P}_t - P_{t-\tau}),$$

where $E1$ and $E2$ denote greenfield and merger entrants, and $p_{x1t-\tau}$ and $p_{x2t-\tau}$ are average labour productivity of close-down and divestiture exits. $p_{xt-\tau}$ is average labour productivity of all exits.[6]

5. In the case of merger entry, the assumption that a firm that enters an industry by acquiring another and replaces that other firm is self-evident.
6. It is calculated as a weighted sum of the average labour productivity of close-down exits and divestiture exits using the corresponding greenfield net-entry and merger net-entry employment as weights. In empirical analysis, it can be proxied by a weighted sum of the average productivity of two exiting categories using employment share as the weight.

3. *Data*

The data for our analysis come from a longitudinal file of manufacturing firms that was constructed from Statistics Canada's Annual Survey (Census) of Manufactures (ASM). The longitudinal version (referred to below as 'LASM') covers the entire Canadian manufacturing sector using both survey and administrative data, and permits plants and firms to be followed over time.[7]

Firms are composed of plants. The LASM contains information at the plant level that can be aggregated together into firms. It collects data on shipments, value added, inventories and employment for about 35,000 manufacturing plants in 1997 (for details, see Statistics Canada, 1979). Gross output in the file is derived as shipments plus net inventory changes. For this study, the plants in the LASM are grouped into 236 manufacturing industries at the 4-digit 1980 Standard Industrial Classification (SIC) level.

Using data on manufacturing plants, we construct variables for each manufacturing firm. The output and employment of a firm is constructed as the sum of the output and employment of all plants that comprise the firm. The industry classification of the firm is the same as its plants' industry classification if the firm operates in a single industry. If the firm operates in several industries, the firm is classified into the industry of its largest plant (the plant with the largest output). There are about 28,000 manufacturing firms in 1997 in the LASM.

The longitudinal file of manufacturing firms developed from the LASM follows firms over the period from 1973 to 1999. Each firm in the file has a unique code that allows us to identify entering, exiting and continuing firms. Entrants are defined as firms that were absent at the start of a period in a particular industry but that had appeared (possessed a plant) at the end of the period, exits as those that were present at the start but were absent at the end of a period, and continuers as those that were present at both the start and end of a period.

In this paper, we distinguish between two types of entry and two types of exit. We divide entrants into those firms that entered an industry by building new plants and those that entered by acquiring existing plants. The former will be called greenfield entry and the latter acquisition or merger entry. Similarly, we divide exiting firms into those that exited by closing down plants and those that exited by divesting plants (close-down exits and divestiture exits, respectively).

We measure market share as the share of a firm in gross output at the 4-digit SIC industry level.[8] Labour productivity is measured as real gross output per worker, where real gross output is derived from deflating nominal output of each firm by an output deflator for the 4-digit SIC industry level in which the firm is classified.[9]

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7. The longitudinal file is maintained by the Micro-economic Analysis Division of Statistics Canada. For a discussion of the file, see Baldwin (1995).
8. Market share is often measured as share of shipments. This paper focuses on the linkage between reallocation of outputs and changes in gross output per worker. Therefore, we use share of gross output as our measure of market share.
9. While value added per worker is the more conventional measure used, gross output per worker is probably more accurately measured in real terms. Real value added per worker is calculated using double deflation techniques that often yield unstable estimates. Nevertheless, sensitivity tests that were performed using value added produced the same qualitative results.

We will examine firm turnover and its contribution to labour productivity growth for two periods: from 1979 to 1989, and from 1989 to 1999. These periods are chosen to give us broad comparability in terms of growth across the business cycle. Each period spans a growth period and allows us to measure the contribution of firm turnover to labour productivity growth over a long enough time period to reduce measurement errors that are associated with short-run changes.[10]

For the analysis in the paper, we have removed those firms that experienced more than 30-fold increases or more than 30-fold declines in labour productivity over a period. Productivity growth of that magnitude in a period of 10 years is unlikely and appears to be a result of reporting errors. We have also removed three industries from the sample where output and employment in some units show large and unrealistic fluctuations over time.[11]

Table 1 presents summary statistics of changes in gross output, labour and labour productivity in the total manufacturing sector.[12] The first column shows annualized changes over the entire data period from 1979 to 1999. The next two columns cover two sub-periods, from 1979 to 1989 and from 1989 to 1999. Our results show that annual labour productivity growth was 2.3% during the period from 1979 to 1999. It increased from 1.3% to 3.2% between the 1979-to-1989 and 1989-to-1999 periods.

Table 1 Summary statistics for the manufacturing sector

	1979 to 1999	1979 to 1989	1989 to 1999
		percent per year	
Δ ln gross output	2.43	1.93	2.94
Δ ln labour	0.16	0.62	-0.29
Δ ln labour productivity	2.27	1.31	3.24

Note: All numbers are the average percentage growth over the period and have been calculated by the authors, using the source mentioned below.
Source: Longitudinal version of Statistics Canada's Annual Survey (Census) of Manufactures (LASM), 1973 to 1999.

10. They also correspond roughly to periods for which the microfile can be used to accurately measure entry. During each of these periods, the comprehensiveness of the frame was allowed to deteriorate slightly; but it was made more comprehensive by the end of the periods chosen. During the periods of deterioration, short-run entry rates are underestimated. Over the longer periods chosen here, this problem is reduced.
11. The three industries are primary production of aluminum (1980 Standard Industrial Classification [SIC] 2951); motor vehicle (SIC 3231); and refined petroleum and coal products (SIC 36).
12. These data will differ slightly from the official productivity statistics because they are taken from underlying microdata rather than the aggregate series used in the productivity accounts that are reconciled with data from other industries within the input/output framework.

4. *Empirical results*

In this section, we first provide basic statistics on the amount of firm turnover arising from firm entry and exit and among incumbents. We then present decomposition results and examine the importance of firm turnover for aggregate labour productivity growth.

4.1 Firm entry and firm exit

For measures of short-term entry, we define entrants in year *t* as firms that were absent in *t-1*, but that appeared in *t*. We define exits in year *t* as firms that were present in *t-1* but absent in *t*. We divide entering firms into entrants by plant creation (greenfield entry) and by plant acquisition (merger entry). We also divide exiting firms into exits by plant closure (close-down exit) and by plant divestiture (divestiture exit). A summary of the average entry and exit rates over the period from 1979 to 1999 is provided in Table 2.

Table 2 Annual average shares of entrants and exits and their labour productivity and size, 1979 to 1999

	Greenfield entrants	Acquisition entrants	Close-down exits	Divestiture exits
Turnover rate (% of firms)	10.6	1.0	10.4	1.3
Turnover rate (% of output)	1.2	3.0	1.3	3.4
Labour productivity	61.20	101.05	58.94	99.71
Output	1.48	3.32	1.65	3.76

Notes: Labour productivity and output of incumbents are normalized to 100.
All numbers have been calculated by the authors, using the source mentioned below.

Source: Longitudinal version of Statistics Canada's Annual Survey (Census) of Manufactures (LASM), 1973 to 1999.

Most firm entrants are greenfield entrants. Over the period from 1979 to 1999, the annual greenfield entry rate (defined as the number of entrants divided by the number of all firms) was 10.6%. The annual merger entry rate was 1.0%. The average size of merger entrants was larger than that of greenfield entrants. As a result, merger entrants account for a larger share of output than greenfield entrants. Over the 1979-to-1999 period, merger entrants account for 3.0% of total output in a year while greenfield entrants account for 1.2% on average in a year.

A similar picture emerges on the exit side. Most firm exits are close-down exits, and the output share of close-down exits was smaller than that of divesture exits. During the period from 1979 to 1999, the close-down exits accounted for 10.4% of the number of firms in a year and 1.3% of output. The divestiture exits represented 1.3% of the number of firms and 3.4% of output.

Annual average labour productivity and size of entrants, exits, and incumbents are also presented in Table 2, with incumbents normalized to 100. The firms that entered manufacturing industries by either building new plants or acquiring existing plants are much smaller than incumbent

firms. Among the entrants, greenfield entrants are the smallest. On average, greenfield entrants had output that was only 1.5% of incumbent firms in the 1979-to-1999 period. Merger entrants had output that was about 3.3% of the output of the incumbents.

Greenfield entrants are less productive than incumbent firms, but are more productive than close-down firm exits. On average, the labour productivity of greenfield entrants was 61% that of incumbents, and the labour productivity of close-down exits was 59% that of incumbents. These results suggest that firm turnover through plant creation and plant closure should make a positive contribution to overall labour productivity of the manufacturing sector. According to our decomposition, entry and exit will raise overall productivity so long as entering firms are more productive than the exiting firms that they replace.

In contrast to the findings for greenfield entrants, merger entrants have labour productivity that is similar to that of incumbent firms. This is consistent with results in Baldwin and Caves (1991). Consistent with previous studies on firm survival (e.g., Baldwin, 1995; Lichtenberg et al., 1987; and Ravenscraft and Scherer, 1991), our results show that the firms that exited from manufacturing industries are much smaller than survivors. During the period from 1979 to 1999, the output of close-down firm exits was 1.7% of survivors and the output of divestiture exits was 3.8% of survivors.

Turnover rates in Table 2 are calculated on an annual basis. The relationship between long-run and short-run turnover depends on the survival rate of entrants. If all entrants survive, the long-run turnover rate will approximate the sum of the annual turnover rates. If all entrants last one year, long-run rates will approximate short-run rates.

Firm turnover rates for longer periods are presented in Table 3. Over the 10-year period, some 60% of firms that were present in 1989 were no longer in operation in 1999. These exiting firms account for 46% of total output and 50% of total employment. Most exiting firms are close-down exits accounting for 53% of the firms, 23% of output and 29% of employment.

Table 3 Firm entry and exit rates in the manufacturing sector, 1979 to 1989 and 1989 to 1999

	% of firms	% of output	% of employment
Period from 1979 to 1989			
Greenfield entry	62.13	12.73	20.24
Merger entry	4.61	20.85	19.62
Close-down exit	51.83	16.33	20.10
Divestiture exit	6.35	22.25	21.60
Period from 1989 to 1999			
Greenfield entry	37.30	8.40	13.82
Merger entry	6.92	25.16	24.45
Close-down exit	52.67	22.93	28.60
Divestiture exit	6.43	22.78	21.24

Note: All numbers have been calculated by the authors, using the source mentioned below.
Source: Longitudinal version of Statistics Canada's Annual Survey (Census) of Manufactures (LASM), 1973 to 1999.

About 45% of firms that were in operation in 1999 are new firms that entered the manufacturing sector during the period 1989 to 1999. These entering firms account for 34% of output and 39% of employment. Most firms that enter the manufacturing sector are greenfield entrants, accounting for 37% of the firms. But their shares in total output and employment are smaller than the shares of merger entrants as greenfield entrants are much smaller than merger entrants.

The greenfield entry rate declined while the merger entry rate increased in the 1990s. The share of greenfield entrants in the number of firms declined from 62% in the 1979-to-1989 period to 37% in the 1989-to-1999 period. In contrast, the share of merger entrants increased from 5% to 7% between the two periods. The 1990s corresponded to a period of restructuring associated with the implementation of free trade agreements with the United States and Mexico. Restructuring during this period would therefore appear to be more closely associated with turnover by mergers than by greenfield entry and close-down exit.

The estimated labour productivity differential between entrants and exits may also vary with the length of a period over which entrants and exits are defined. Entrants at birth are likely to have a lower average productivity than the entering firms that survive over a period of time because of selection and learning effects. The cohort of surviving entrants may also move up relative to the incumbent population (Baldwin and Rafiquzzaman, 1995).

Similarly, the base-year productivity of the firms that exit over a one-year period should be lower in comparison to those firms that exit over a longer period, if the firms that last longer are the more productive ones.

When we define entrants and exits over a longer period, merger entrants still have higher labour productivity than divestiture exits (Table 4). Greenfield entrants have higher labour productivity than close-down exits in the 1990s but lower labour productivity than close-down exits in the 1980s. The lower labour productivity of greenfield entrants relative to close-down exits in the 1980s is due to a compositional effect, whereby exit is concentrated in high-productivity industries and entry in low-productivity industries. After controlling for the compositional effect at the 4-digit Standard Industrial Classification (SIC) industry level, we find that greenfield entrants also have higher labour productivity than closedown exits in the 1980s.

These results suggest that firm entry and exit associated with plant creation and plant acquisition should both make a positive contribution to overall labour productivity of the manufacturing sector.

Table 4 Relative labour productivity of entrants, exits and incumbents

	Start year	End year
Period from 1979 to 1989		
Greenfield entrants	...	68.05
Merger entrants	...	114.96
Close-down exits	77.16	...
Divestiture exits	97.80	...
Incumbents	100.00	119.52
Period from 1989 to 1999		
Greenfield entrants	...	77.62
Merger entrants	...	131.39
Close-down exits	74.07	...
Divestiture exits	99.09	...
Incumbents	100.00	137.46

... not applicable

Note: All numbers have been calculated by the authors, using the source mentioned below.

Source: Longitudinal version of Statistics Canada's Annual Survey (Census) of Manufactures (LASM), 1973 to 1999.

4.2 The growth and decline of incumbents

In this section, we present statistics on the amount of firm turnover among incumbents as measured by change in market share. We define the market share of a firm as the share of total gross output at the 4-digit SIC industry level and calculate the annual change in market share of the firms that gained market shares (growing firms) and the firms that lost market share (declining firms). We find that annual firm turnover among incumbents is more substantial than turnover arising from entry and exit. During the 1979-to-1999 period, the growing firms gained an additional 7.6 percentage points in market share in a year while the declining firms lost 6.9 percentage points. By comparison, the results in Table 2 show that entering firms (both greenfield and merger entrants) captured 4.2 percentage points in a year and exiting firms (both close-down and divestitures) relinquished 4.7 percentage points.

We have also calculated change in market share over the periods from 1979 to 1989 and from 1989 to 1999. The measure for the longer period reflects the cumulative change over the period. The results shown in Table 5 indicate that firm turnover among incumbents over a 10-year period is less important than turnover due to firm entry and exit. Over the period from 1989 to 1999, the growing incumbents gained 24.7 percentage points in market share while the declining incumbents lost 12.6 percentage points. By comparison, our results in Table 3 show that entering firms captured 33.6 percentage points in market share over the period and exiting firms lost 45.7 percentage points. During the period from 1989 to 1999, a total of 58.0% of market share was transferred from firms that either contracted or closed to new firms or firms that expanded. This confirms earlier evidence taken from the 1970s (Baldwin, 1995, Chapter 4) that large shifts take place in the market share of manufacturing firms and most shifts are a result of firm entry and exit.

Table 5 Percentage of market-share changes of growing and declining incumbents, 1979 to 1989 and 1989 to 1999

	Start year	End year	Changes
Period from 1979 to 1989			
Market-share gainers	22.53	43.84	21.30
Market-share losers	38.88	22.59	-16.30
Period from 1989 to 1999			
Market-share gainers	24.06	48.78	24.72
Market-share losers	30.23	17.66	-12.57

Note: All numbers have been calculated by the authors, using the source mentioned below.
Source: Longitudinal version of Statistics Canada's Annual Survey (Census) of Manufactures (LASM), 1973 to 1999.

Table 6 Labour productivity and size of growing and declining incumbents

	Labour productivity		Size	
	Start year	End year	Start year	End year
Period from 1979 to 1989				
Market-share gainers	92.05	118.81	57.95	136.68
Market-share losers	100.00	110.49	100.00	70.43
Period from 1989 to 1999				
Market-share gainers	87.40	133.58	79.58	216.58
Market-share losers	100.00	118.49	100.00	78.40

Note: All numbers have been calculated by the authors, using the source mentioned below.
Source: Longitudinal version of Statistics Canada's Annual Survey (Census) of Manufactures (LASM), 1973 to 1999.

The importance of entering and exiting firms in turnover relative to that of incumbents increases over time. Over a one-year period, the market-share change that is due to entry and exit is less important than that of incumbents. In contrast, over a 10-year period, the amount of turnover from firm entry and exit is more important than turnover from incumbents. Baldwin (1995, Chapter 4) presents similar evidence for the 1970s.

In Table 6, we compare the labour productivity and size of market-share gainers with that of market-share losers. We find that high labour productivity *at the start of a period* is not a good predictor of growth in market share in a subsequent period. The firms that gained market share over a period have lower labour productivity at the start of the period than those that lost market share. However, high labour productivity *at the end of a period* is positively linked to growth in market share. The firms that gained market share are more productive at the end of the period as a result of faster labour productivity growth.[13] The results suggest that market-share shifts among incumbents should make a positive contribution to aggregate labour productivity. According to our decomposition, market-share reallocation raises aggregate labour productivity when there are shifts in market share towards the firms that are more productive at the end of a period from those that are less productive.

13. This is a phenomenon that has been repeatedly found in studies of the Canadian manufacturing sector (Baldwin, 1995; Baldwin and Sabourin, 2004).

The results from estimating regressions that relate change in market share to labour productivity across incumbents confirm that market-share change is positively related to labour productivity growth among incumbents for both the 1989-to-1999 and 1979-to-1989 periods. It is also positively linked to labour productivity at the end of a period. But the relationship between market-share change and labour productivity at the start of a period is not statistically significant.[14]

The results also show that market-share gainers are smaller than market-share losers in terms of gross output at the start of a period. But, by the end of a period, market-share gainers become much bigger as a result of faster output growth (Table 6).

4.3 Contribution of firm turnover to labour productivity growth

The decomposition results for an average 4-digit Canadian manufacturing industry for the periods from 1979 to 1989 and from 1989 to 1999 are presented in Table 7. The decomposition is carried out at the 4-digit SIC industry level, and the results are then aggregated to the level of the total manufacturing sector using employment as weights. We divide the effect of within-firm growth into two parts—a portion that comes from growth in continuing firms gaining market share and a portion in continuing firms losing market share—since earlier work (Baldwin, 1995; Baldwin and Gu, 2006) found that most of the within-plant's own effect comes from plants that are expanding and that very little comes from those contracting. The latter group is in the process of losing market share, primarily because it has fallen behind in the productivity race.

Table 7 Decomposition of labour productivity growth in manufacturing industries at the firm level

	1979 to 1989	1989 to 1999
Percentage of contribution to labour productivity growth		
Labour productivity growth at growing incumbents	23.77	21.54
Labour productivity growth at declining incumbents	4.03	9.72
Output reallocation within incumbents	48.23	39.83
Greenfield entry and close-down exit	4.78	4.64
Merger entry and divestiture exit	19.19	24.27
Addendum: components of the contribution from the growth within incumbents		
Pure productivity effect	42.39	46.40
Market-share gainers	32.56	31.59
Market-share losers	9.82	14.81
Covariance	-14.59	-15.14
Market-share gainers	-8.79	-10.06
Market-share losers	-5.80	-5.08
Total of pure productivity effect and covariance	27.80	31.26

Note: All numbers have been calculated by the authors, using the source mentioned below.
Source: Longitudinal version of Statistics Canada's Annual Survey (Census) of Manufactures (LASM), 1973 to 1999.

14. For the period from 1979 to 1989, the coefficient on initial labour productivity is negative with t-statistics of 1.69. For the period from 1989 to 1999, the coefficient is positive with t-statistics of 1.20.

The results show that firm turnover and output reallocation are more important than within-firm growth for aggregate labour productivity growth. For both the 1979-to-1989 and 1989-to-1999 periods, about 70% of aggregate productivity growth was due to output reallocation arising from net entry and the growth and decline of continuing firms. The remaining 30% is accounted for by productivity growth at continuing firms.

Of the 70% contribution from output reallocation over the 1989-to-1999 period, 40 percentage points come from reallocation of market share across continuing firms, 24 percentage points from merger and acquisition, and 5 percentage points from greenfield entrants and close-down exits. The contribution to aggregate productivity growth of the three categories of firm turnover over the period from 1979 to 1989 is similar to their contribution over the period from 1989 to 1999. These results suggest that the reallocation of output within incumbents makes a bigger contribution to aggregate productivity growth than the displacement of exiting firms by entering firms. New firms that entered manufacturing industries by acquiring existing plants are more important for aggregate labour productivity growth than new firms that entered by building new plants.

While we have included the effect of mergers and divestitures in the entry component because they clearly contribute to bringing new entities into an industry and therefore constitute a form of entry, an argument can be made that not all of the productivity growth therein should be treated as coming from the turnover process. The estimated contribution of firm turnover due to merger and acquisition captures both the causal effect of ownership changes and the growth that would have occurred without ownership changes. A number of studies find that some of the growth at merger entrants is the effect of merger and acquisition. Lichtenberg (1992), and McGuckin and Sang Nguyen (1995) find that there is a positive relationship between ownership changes and productivity growth. Following a change in ownership, the plants enjoyed above-average productivity growth for several years. Baldwin and Caves (1991) find similar evidence in Canadian manufacturing plants.

While these findings suggest mergers impact on productivity growth, there is doubtlessly a component that is more appropriately included in the within-firm component—as a result of productivity growth that would have occurred without mergers. If we remove the merger component from the between-firm effect and transfer it to the within-firm component, the effect of turnover falls from some 70% to around 50%. In the absence of further work on mergers, we conclude that the true answer to the effect of turnover falls somewhere between these two bounds.

Most of the within-firm contribution to aggregate productivity growth comes from the firms that gain market share. Our results show that productivity growth at growing firms accounted for 21.5% of aggregate productivity growth while declining firms accounted for 9.7% during the 1989-to-1999 period. For the 1979-to-1989 period, growing firms contributed 23.8% and declining firms contributed 4.0%. The competitive process is such that most productivity growth occurs in those gaining market share. Or more importantly, those who are losing market share are basically in a state of hiatus with regards to productivity growth. These are the firms that have not found much in the way of innovative methods to increase productivity.

Table 8 The sources of market-share growth in incumbents

	1979 to 1989	1989 to 1999
Market-share gainers	21.30	24.72
Growing plants	8.79	14.42
Declining plants	-1.84	-1.58
New plants	15.25	15.16
Closed plants	-0.89	-3.28
Market-share losers	-16.30	-12.57
Growing plants	1.19	0.94
Declining plants	-6.93	-7.01
New plants	3.29	3.01
Closed plants	-13.85	-9.51

Notes: This table presents the contribution in percentage of plant change to firm share change.
All numbers have been calculated by the authors, using the source mentioned below.

Source: Longitudinal version of Statistics Canada's Annual Survey (Census) of Manufactures (LASM), 1973 to 1999.

The contribution of output reallocation and firm turnover to labour productivity growth is similar between the two periods—from 1979 to 1989 and from 1989 to 1999. The contribution of firm turnover due to merger and acquisition showed a small increase in the period from 1989 to 1999.

The contribution that output reallocation made to aggregate labour productivity growth in Canadian manufacturing industries can also be calculated across plants (as opposed to firms). Plant turnover will differ from firm turnover because firms are not only changing position relative to one another but they are reinventing themselves by opening and closing plants (Table 8). The gain of 24.7 percentage points experienced by the growing firm sector from 1989 to 1999 consists of increases of 14.4 percentage points from growing plants, 15.2 percentage points from new plants, a loss of 1.6 percentage points from declining plants, and a loss of 3.3 percent points because of closed plants. New plant creation is just as important for growers as the expansion of existing plants. The 12.6 percentage points lost by declining firms over the same period came from a loss of 7.0 percentage points in declining plants, and a loss of 9.5 percentage points from closed plants; but even this group was attempting to reinvent itself (albeit with little success) because its market-share change was partially due to some expanding plants (0.9 percentage points) and some new plants (3.0 percentage points).

When the breakdown of productivity growth is done at the plant rather than the firm level (Table 9), within-plant growth comes mainly from the plants that are growing rather than the plants that are in decline—just as it does in the firm decomposition. The across-plant reallocation accounted for 68.4% and 65.0% of aggregate labour productivity growth in an average SIC-classified, 4-digit Canadian manufacturing industry over the periods from 1979 to 1989 and from 1989 to 1999. This is slightly smaller than the contribution from the reallocation of output across firms reported in Table 7.

Table 9 Decomposition of labour productivity growth in manufacturing industries at the plant level

	1979 to 1989	1989 to 1999
Percentage of contribution to labour productivity growth		
Labour productivity growth at growing incumbents	41.74	29.38
Labour productivity growth at declining incumbents	-10.14	6.01
Output reallocation within incumbents	49.99	48.39
Greenfield entry and close-down exit	18.40	16.22
Addendum: components of the contribution from the growth within incumbents		
Pure productivity effect	36.32	53.45
Market-share gainers	56.45	41.81
Market-share losers	-20.13	11.64
Covariance	-4.71	-18.07
Market-share gainers	-14.70	-12.44
Market-share losers	9.99	-5.63
Total of pure productivity effect and covariance	31.61	35.38

Note: All numbers have been calculated by the authors, using the source mentioned below.
Source: Longitudinal version of Statistics Canada's Annual Survey (Census) of Manufactures (LASM), 1973 to 1999.

Some of this difference occurs because plants that were ongoing with merged entities are re-classified as acquisition entry and divestiture exits in the firm-based decomposition. In the plant-based analysis, this group would make up part of the within-plant component. When this is removed from the total reallocation component in the firm-based decomposition, the proportion of aggregate productivity growth arising from reallocation falls to 53% in the period from 1979 to 1989 and 43% in the period from 1989 to 1999. This is somewhat lower than the reallocation component calculated from plant data—probably because all of plant entry and exit is attributed to turnover in the plant decomposition, whereas some of this will be included in the within-firm component because continuing firms open and close plants.

In our decomposition, we assume that greenfield entrants replace close-down exits and merger entrants replace divestiture exits. Baldwin (1995, Chapter 9) has provided empirical evidence in favour of this replacement assumption at the plant level. To provide empirical evidence for the replacement assumption at the firm level, we estimate a regression that relates the output share of close-down exits to the output share of greenfield entrants, the output share of merger entrants, and the increase in output share of continuing firms that gained output shares. We also estimate regressions that relate the share of divestiture exits and the decline in the share of declining incumbents to the three growing categories. The regressions are estimated from the cross-sectional data of 4-digit SIC industries over the two periods from 1979 to 1989 and from 1989 to 1999 (Table 10).

Table 10 Cross-industrial relationship between market-share loss and market-share gain at the firm level

	Dependent variable		
	Share of close-down exits	Share of divestiture exits	Change in share of declining incumbents
Independent variable			
Output share of greenfield entrants	0.637	0.051	0.312
	(13.42)	(1.28)	(8.19)
Output share of merger entrants	0.300	0.557	0.143
	(7.79)	(14.39)	(4.99)
Change in output share of growing incumbents	0.412	0.378	0.210
	(8.01)	(7.68)	(5.29)
Number of observations	438	438	438
R squared	0.73	0.71	0.49

Notes: Robust t-statistics are in parentheses.
Regression results from pooling firm turnover data over two periods: 1979 to 1989 and 1989 to 1999.
All numbers have been calculated by the authors, using the source mentioned below.

Source: Longitudinal version of Statistics Canada's Annual Survey (Census) of Manufactures (LASM), 1973 to 1999.

The coefficient on a variable indicates the extent to which a 1% increase in a growing category is associated with the replacement of a declining category. The coefficients sum to one in each row. The coefficients on the output share of greenfield entrants show that a one-percentage-point increase in the share of greenfield entrants is associated with a 0.64-percentage-point increase in the share of close-down exits and a 0.31-percentage-point decline in the share of declining incumbents. It is also associated with a 0.05-percentage-point increase in the share of divestiture exits, but the relationship is not statistically significant at the 5% level. This suggests that greenfield entrants replace both close-down exits and continuers that lost market shares. But the replacement effect is much stronger on close-down exits.

The coefficients on the output share of merger entrants in the second row suggest that merger entrants replace all three declining categories but have a stronger effect on divestiture exits. The results in the third row show that the continuers that gained market shares have a similar effect on close-down exits and divestiture exits, and a smaller effect on the continuers that lost market shares.

The replacement pattern presented in Table 10 is more complicated than the replacement assumption that is made in our original decomposition. Under the more complex replacement pattern, the contribution of entrants to aggregate productivity growth should be derived by comparing entrants with the firms that those entrants displace. It is calculated as the product of the share of entrants times the productivity differential between entrants and the firms that the entrants replace. The decomposition (Equation 17) based on a complex replacement pattern becomes

$$P_t - P_{t-\tau} = \sum_{i \in C}(s_{it} - \hat{s}_{it})(p_{it} - p_{Dt-\tau}) + \sum_{i \in E1} s_{it}(p_{it} - p_{D1t-\tau}) + \sum_{i \in E2} s_{it}(p_{it} - p_{D2t-\tau})$$

(18)

$$+(\hat{P}_t - P_{t-\tau}),$$

where $D1$ denotes the set of firms that greenfield entrants displace, $D2$ the set of firms that merger entrants displace, $p_{D1t-\tau}$ and $p_{D2t-\tau}$ are the average labour productivity of firms in sets $D1$ and $D2$, and $p_{Dt-\tau}$ is the average labour productivity of all displaced firms.[15] The replacement pattern in Table 10 suggests that $p_{D1t-\tau}$ and $p_{D2t-\tau}$ can be estimated as

$$p_{D1t-\tau} = 0.64p_{x1t-\tau} + 0.05p_{x2t-\tau} + 0.31p_{DCt-\tau}, \text{ and}$$

(19)

$$p_{D2t-\tau} = 0.30p_{x1t-\tau} + 0.56p_{x2t-\tau} + 0.14p_{DCt-\tau},$$

where $p_{x1t-\tau}$ and $p_{x2t-\tau}$ are the average labour productivity of close-down exits and divestiture exits, and $p_{DCt-\tau}$ is the average labour productivity of continuing firms that lost market shares.

Table 11 Decomposition of labour productivity growth using alternative replacement assumptions

	Complex replacement pattern		Simple replacement pattern	
	1979 to 1989	1989 to 1999	1979 to 1989	1989 to 1999
Labour productivity growth at growing incumbents	24.91	21.19	23.77	21.54
Labour productivity growth at declining incumbents	3.40	9.46	4.03	9.72
Output reallocation within incumbents	48.14	39.72	48.23	39.83
Greenfield entry and close-down exit	-0.49	2.88	4.78	4.64
Merger entry and divestiture exit	24.04	26.75	19.19	24.27

Notes: This table presents the percentage of contribution to labour productivity growth.
All numbers have been calculated by the authors, using the source mentioned below.

Source: Longitudinal version of Statistics Canada's Annual Survey (Census) of Manufactures (LASM), 1973 to 1999.

The results using the decomposition (18) are presented in Table 11. For a comparison, the results derived using the decomposition (17) are also presented in the table. We find that there is little difference between the two sets of results. This indicates that our decomposition using a simple replacement assumption basically yields the correct answer.

15. It can be calculated as $(s_{E1}p_{D1t-\tau} + s_{E2}p_{D2t-\tau} - \hat{s}_{x1}p_{x1t-\tau} - \hat{s}_{x2}p_{x2t-\tau})/(s_{E1} + s_{E2} - \hat{s}_{x1} - \hat{s}_{x2})$, where s is the employment share of an entering or exiting category. In empirical analysis, it can be proxied by a weighted sum of the average labour productivity of the two sets of displaced firms.

5. *Sources of labour productivity growth: Alternative decomposition*

Our finding on the importance of firm turnover and output reallocation differs from those in many previous empirical studies. Most previous studies find that entry contributes little to productivity growth and that the reallocation process across continuing firms makes a small and often negative contribution to aggregate productivity growth (Hazledine, 1985; Foster, Haltiwanger and Krizan, 2001; Organization for Economic Co-operation and Development [OECD], 2001; and Griliches and Regev, 1995). These studies argue that almost all productivity growth comes from the within-firm component.

It is important to explain why these studies yield different results from ours. In this section, we argue that the main difference between our approach and those in previous studies lies in the counterfactuals about the competitive process that underlies each. Our decomposition assumes that the competitive process leads to shifts in market share across firms. Without competition, there would be no shifts in market shares. The firms that are more competitive and more productive would not gain market share from the less-competitive firms. The decomposition in most previous studies makes use of a method that assigns to the within-firm or plant productivity gain not only the organic productivity growth within firms or plants but also the shifts in market share. These studies then describe the effects of the competitive process as the effects of the reallocation of employment across firms. In contrast, our decomposition method measures the contribution from the reallocation of output.

Since studies on business strategies suggest that competition and corporate success is about businesses gaining markets from their competitors, our measure should provide a better indicator of the importance of the competitive process for aggregate productivity growth. In effect, what others call the within-firm component captures both the within-firm growth effect that we have defined and a substantial portion of the productivity growth that arises from shifts in market share.

We consider two other decomposition methods: one by Griliches and Regev (1995) (abridged as GR) and the other by Foster, Haltiwanger and Krizan (2001) (abridged as FHK). These two decomposition methods have been recently adopted by the OECD in their inter-country comparison of the importance of entry and exit for productivity growth in OECD countries (OECD, 2001).

The decomposition due to Griliches and Regev (1995) is

$$\Delta P_{t,t-\tau} = \sum_{i\in C} \overline{s_i}(p_{it} - p_{it-\tau}) + \sum_{i\in C}(s_{it} - s_{it-\tau})(\overline{p_i} - \overline{P})$$

(20)

$$+\sum_{i\in E} s_{it}(p_{it} - \overline{P}) - \sum_{i\in X} s_{it-\tau}(p_{it-\tau} - \overline{P}).$$

where Δ denotes changes between two periods t and $t-\tau$. A bar over a variable indicates the average of the variable over the two periods, C denotes continuing firms that are in operation in both periods, E denotes entering firms and X denotes exiting firms.

The first term in the decomposition is categorized by these authors as the within-firm component and is taken to measure the contribution of productivity growth taking place within continuing firms. The second term is referred to as the between-firm component and captures the effect of the compositional shift in employment shares among continuing firms. The between-firm component is positive when labour shifts toward the firms that are more productive. The last two terms are taken to represent the contribution of firm entry and exit. The sum of the last three terms is taken to measure the effect of reallocation across individual firms.

Foster, Haltiwanger and Krizan (2001) use a modification of the same approach. Rather than averaging shares and productivity between the two periods, they use initial shares and productivity:

$$\Delta P_{t,t-\tau} = \sum_{i\in C} s_{it-\tau}(p_{it} - p_{it-\tau}) + \sum_{i\in C}(s_{it} - s_{it-\tau})(p_{it-\tau} - P_{t-\tau})$$

(21)

$$+\sum_{i\in C}(s_{it} - s_{it-\tau})(p_{it} - p_{it-\tau}) + \sum_{i\in E} s_{it}(p_{it} - P_{t-\tau}) - \sum_{i\in X} s_{it-\tau}(p_{it-\tau} - P_{t-\tau}).$$

The first and second terms are referred to by the authors as the within-firm component and the between-firm component. The third term is the covariance term in shares and productivity across continuing firms. The last two terms are taken to represent the contribution of entry and exit.

The entry and exit components in the FHK and GR methods involve a comparison with the productivity of an average firm. Entering firms are said to contribute positively to aggregate productivity if their productivity in the end period exceeds that of an average firm. For exiting firms, the contribution is said to be positive if they are less productive than an average firm.

To show the empirical difference that these methods produce, we have recalculated the impact of reallocation using the GR and FHK decompositions. The results from the FHK and GR decompositions in Tables 12 and 13 suggest that reallocation within continuing firms made little and even a negative contribution to aggregate labour productivity growth. These results stand in sharp contrast to the results from our decomposition that show the important contribution made by the between-firm reallocation.

Table 12 Decomposition of labour productivity growth in manufacturing industries, GR[1] method for firms

	1979 to 1989	1989 to 1999
Labour productivity growth at incumbents	72.53	66.18
Employment reallocation within incumbents	0.90	-1.87
Greenfield entry	-11.90	-3.76
Merger entry	11.67	12.06
Close-down exit	- 14.52	16.46
Divestiture exit	12.27	10.93

1. Griliches and Regev (1995).

Notes: This table presents the percentage of contribution to labour productivity growth.
All numbers have been calculated by the authors, using the source mentioned below.

Source: Longitudinal version of Statistics Canada's Annual Survey (Census) of Manufactures (LASM), 1973 to 1999.

Table 13 Decomposition of labour productivity growth in manufacturing industries, FHK[1] method for firms

	1979 to 1989	1989 to 1999
Labour productivity growth at incumbents	77.20	65.71
Employment reallocation within incumbents	9.80	2.05
Co-variance	-9.34	0.95
Greenfield entry	-7.27	0.72
Merger entry	21.26	23.93
Close-down exit	8.29	6.10
Divestiture exit	0.05	0.55

1. Foster, Haltiwanger and Krizan (2001).

Notes: This table presents the percentage of contribution to labour productivity growth.
All numbers have been calculated by the authors, using the source mentioned below.

Source: Longitudinal version of Statistics Canada's Annual Survey (Census) of Manufactures (LASM), 1973 to 1999.

In a related paper (Baldwin and Gu, 2002), we argue that the method that is used by FHK and GR improperly measures the contribution of entry and exit alone to productivity growth.[16] But we also note that these conventional estimates for entry and exit, when summed, closely approximate the net effect of entry and exit derived from the counterfactual that we employ here. It is therefore noteworthy that the measured contribution of the combined effects of entry and exit from the FHK and GR decompositions is often similar to the one from our decomposition.

The difference in the contribution made by turnover derived from our decomposition as opposed to that from the GR or FHK decompositions lies in the counterfactual that underlies each. The reallocation effect from our method is estimated using the counterfactual that without competition, productivity in each firm would have grown by the same amount that was actually experienced and that market shares would not have changed.

In contrast, the implicit counterfactual that is being made in the GR and FHK methods when measuring the within-firm effect is quite different. The within-firm or pure productivity component in these two approaches involves a term that is the product of constant employment share and productivity changes. Those who use these models are presuming the following counterfactual—that without competition, productivity in each plant or firm would have grown by the same amount that was actually observed and that employment shares would not have changed. This assumption is not neutral with respect to market share, for with constant employment share and changing relative productivity, market share will change. Since firms that have faster labour productivity growth over a period tend to have higher labour productivity at the end of a period in our data, this reallocation of output is towards those firms that are more productive at the end of a period. What is worse, the GR and FHK methods assume that productivity gains are perfectly reflected in market-share changes. If employment share is held constant, market share must change exactly the same amount as productivity changes in their approach. Perhaps equally problematic is that this assumption of market shares changing in

16. The implicit assumption embedded in the counterfactual that generates the formula used by FHK/GR approach is that entrants replace existing firms rather than exits.

proportion to productivity changes rarely occurs.[17] The within-firm effect in FHK/GR thus incorporates the effect of changing market shares (and an incorrect one at that) and thus cannot be interpreted as a pure productivity effect.

Consider, for example, an industry in which all firms have different labour productivity growth rates and output really does increase at the same rate as labour productivity for each firm. The GR and FHK decompositions will attribute all of the aggregate labour productivity growth to the effect of within-firm growth because it combines both within-firm and between-firm effects from market-share change. On the other hand, our decomposition will attribute a part of the aggregate productivity growth to the reallocation of output. According to our decomposition, the reallocation of output has a positive effect on aggregate labour productivity when output share shifts toward those firms that are more productive at the end of a period.

The within-firm component in the GR and FHK approaches combines the within-firm productivity growth as defined in this paper and a portion of productivity growth from market-share changes. As a result, the residual term (the between-firm effect in GR and FHK)—the portion of productivity growth that is not accounted for by the within-firm component—must be corrected for the portion of the market-share change that is incorrectly included in the first term if, as explained, the actual market-share change is not proportional to labour productivity changes.[18] Consequently, the estimated remaining term (or terms) from the FHK and GR methods to define the between-firm effect is often small or negative.

The within-firm terms of the alternate FHK/GR decompositions then really combine the effects of productivity changes within firms and the response of market-share changes to the changes in labour productivity. Of course, in some circumstances, we might want to capture the amount of productivity growth that comes both from the productivity growth of firms and from the response of market shares to productivity growth. For this measure, in some sense, better captures the sum of change that is due to competition. But if the measurement exercise is meant to provide estimates of this competitive process, we believe there is an alternate breakdown that is more transparent of the underlying process at work.

We have argued that competition leads some firms to perform better and that their superior performance results in gains in market share. We have used the between-firm component to capture the effect of competition in this study. Nevertheless, we recognize that our estimate of 50% to 70% probably underestimates the impact of competition.

Competition is about gaining an advantage. Our results show that the firms that try hardest—that is, are most successful in improving their productivity—are the most successful in gaining market share. Indeed, those gaining market share account for most of the within-firm component of productivity growth. Arguably, the component of productivity growth generated by those firms *gaining* market share should also be included in an overall estimate of the impact of the competitive process.

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17. The correlation coefficient between labour productivity growth in the 1989-to-1999 period and labour productivity in 1999 across firms is positive and statistically significant.
18. The estimated elasticity of output with respect to labour productivity is 0.6 in the Canadian manufacturing firms over the period from 1989 to 1999.

In Table 7, we have divided the within-firm contribution into contributions from market-share gainers as opposed to market-share losers. As we have shown, the competitive process is associated with different productivity growth rates for market-share gainers and losers. Market-share gainers do much better than market-share losers because presumably, they are innovating more intensively. There is still some gain within the group of market-share losers but it is not large. If we presume that the productivity growth of market-share losers is essentially exogenous, then it should be excluded from the total effect that is due to innovation and competition. If we do so, most of the productivity growth would be attributed to the competitive process—over 90%.

5.1 Comment on the decomposition of total factor productivity growth

In this paper, we have focused on the decomposition of aggregate labour productivity growth. We have argued that the between-firm effect of the FHK and GR decompositions underestimates the contribution of the competitive process to aggregate labour productivity growth. These decompositions measure the contribution of employment reallocation rather than that of output reallocation.

Others have focused on the contribution to total factor productivity growth—Aw, Chen, and Roberts (1997) for Taiwan; Liu and Tybout (1996) for Chile and Colombia; Disney, Haskel and Heden (2003) for the United Kingdom; Baily, Hulten and Campbell (1992), Haltiwanger (1997), and Foster, Haltiwanger and Krizan (2001) for the United States. Ahn (2001) observed that decompositions that use total factor productivity (TFP) generally have found that the contribution of firm dynamics is much greater than those that examine labour productivity growth.

This occurs because these studies generally weight productivity changes at the microlevel, not by inputs like labour but by output, because this is the natural metric to use when aggregating from individual units to aggregate productivity.[19] When the FHK and GR decomposition methods (Equations 20 and 21) are used to measure the contribution of firm turnover to the TFP growth using output, the between-firm component will correctly capture the contribution to aggregate TFP growth from the reallocation of output. The between-firm component will be positive if output shifts toward firms with higher TFP.[20]

While the TFP decompositions are therefore inherently less problematic than the conventional labour productivity compositions when it comes to the aggregators used, they still suffer from a different conceptual weakness.[21] The FHK and GR decompositions may still improperly measure the contribution of entry and exit alone to aggregate TFP growth if competition is essentially between entrants and exits. The FHK and the GR decompositions involve a comparison of

19. Domar (1961).
20. The exception in the above list is Liu and Tybout (1996) who use an input index for the weights and who therefore find that a much larger share of total TFP gain comes from the within-firm component.
21. They also suffer from greater measurement problems than do the labour decompositions, because TFP calculations require estimates of the growth in real capital stock—a variable that is difficult to measure accurately at the industry level and whose accuracy is highly problematic in most microdata bases.

entrants with an average incumbent and assume that entrants displace incumbents. The evidence from Canadian manufacturing firms suggests that entrants primarily displace exits. A correct decomposition for Canada should compare entrants with exits and measure the contribution of net entry as the product of the output share of entrants multiplied by the TFP difference between entrants and exits. At least the pattern of replacement should be formally investigated for the country being studied and the results incorporated into the estimating formula as is done herein.

6. Conclusion

In this paper, we have examined the contribution that the reallocation of outputs across firms has made to productivity growth in Canadian manufacturing over the last two decades. We find that a main source of productivity growth in Canadian manufacturing industries is the competitive process that shifts output shares toward the firms that are more productive. For Canadian manufacturing industries, about 70% of overall labour productivity growth is due to changes in market share across firms in the periods from 1979 to 1989, and from 1989 to 1999 (around 50% if the effect of mergers is removed).

The paper also asks why others have reported that reallocation contributes little to labour productivity growth. There are two reasons for this, both revolving around incorrect counterfactuals. First, alternate decompositions essentially include market-share changes in their within-firm component. Secondly, they incorporate characterizations of the dynamic replacement process that are often inappropriate—or at least not investigated. In an earlier paper (Baldwin and Gu, 2002), we showed that conventional formulae that are used to measure the importance of entry and exit from new plant creation and old plant closure incorrectly measure the contribution of this process to productivity growth—these papers implicitly assume that entrants replace continuing firms without asking whether this is reasonable. When the impact of entry is calculated from an alternate assumption (that entrants replace exits most of the time), the contribution of entry to productivity growth increases substantially.

In this paper, we extend our analysis to measure the contribution of changing market share within the incumbent population. Whether it comes from entry and exit, or growth and decline in incumbents, the reallocation of market share has a considerable impact on productivity growth. Other researchers, who argue that productivity growth comes primarily from productivity growth that is internal to firms, have implicitly included much of the effect of reallocating market share in their within-firm productivity term. The large numbers they obtain combine the within-firm productivity effect and the reallocation effect that we have separated in this paper.

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